

PMT Group Response to MicroBooNE Internal PMT Review  
September 1, 2010

The MicroBooNE WBS 1.8 team will strive to implement the recommendations made in the internal review so that goals are met well in time for the upcoming Director's and CD-2 review. The notes below are organized modeling the review report, with responses to recommendations made for each question from the original charge.

**1. Does the present plan for the PMT placement and photon collection meet the needs of the experiment?**

Recommendations:

None, since current system seems adequate to meet the experimental goals and requirements set for the experiment.

**2. Has there been sufficient prototyping to demonstrate the performance and reliability of the system? What additional prototyping testing is needed? Are people identified that can carry out this program?**

Recommendations:

a) The group should proceed towards final optimization of the adopted coating solution (TPB+PS on acrylic) with further prototyping and tests on the TPB coating and plate preparation, plate degradation, and recovery. This should aim to cross check and fine tune the solution under consideration for the CD-2 review. Ideally, tests with Hamamatsu 5912 PMT at 128 nm (with a light source or with GAr scintillation light) would be best suited for this purpose.

b) For the future program after the CD-2 review, a test run with an array of 2 to 4 PMTs with [TBP+PS]-coated-plates in LAr with realistic read-out electronics would give a test characterization and "endurance tests" of the light detection system.

c) The Group is very active with well proved expertise and skill and has made impressive progress on developing innovative solutions for this state-of-art system. Some additions to strengthen the manpower at Fermilab for current and future prototyping and production testing may be desirable to fully exploit the facilities and setups at Fermilab.

Response:

a) Final optimization of the adopted TPB coating solution is now being tested at MIT using thermal annealing of the plates and storage in a dry box to minimize moisture.

b) The group will conduct a test run with 2-4 PMTs and coated plates for longevity after the CD2, complete with electronic readouts, as recommended.

c) There has been one full time addition to the PMT group since August, working half time specifically to provide manpower for prototyping and production testing. More manpower is readily available to be accessed if it becomes necessary, however at this time current manpower is more than adequate.

- 3. Have the systems been tested sufficiently in cryogenic condition? Have they had sufficient material testing to assure that the materials will not poison the liquid argon?**

Recommendations:

Since nitrogen has some absorption of the UV light produced (and affects the production of the long decay time light), the PMT group should decide on a specification for the maximum permissible nitrogen concentration and communicate this to the Cryogenics group.

Response:

The PMT group will determine the maximum permissible nitrogen concentration and convey this to the Cryogenics group by late September.

- 4. Is there sufficient redundancy in the system such that if a small part of it fails, the experiment will still succeed?**

Recommendations:

Increasing the expected light-yield comfortably above the minimum requirement is recommended to allow for unexpected losses of the actual light yield. If needed, this might be accomplished by extensions of the active photocathode coverage with more PMT's or by wavelength shifting, reflecting and collecting part of the light at the boundary surfaces of the detector.

Response:

The current plan of 30 PMTs has a worst case positioning scenario of 13 photoelectrons per 5 MeV. With the trigger set at 10 photoelectrons, roughly equivalent to 5 MeV, there is already a safety margin even in the worst case scenario. However the group can investigate the suggestions of ways to extend active photocathode coverage if necessary based on the results of Monte Carlo simulations, without compromising other factors such as reconstruction.

- 5. Is the quality assurance plan sufficient for assuring a reliable finished product? Has sufficient manpower been identified to carry out this program?**

Recommendations:

The group's plans are sufficiently advanced that it could consider post CD2 tests such as a long term (several months) PMT and TPB plates test, and a "vertical slice test" including the whole chain from PMT through feed through and readout.

Response:

Following the CD-2 review and after prototype electronics become available, the PMT group plans to do a vertical slice test for the electronics.

- 6. Have the interfaces with the other WBS's been defined? Have these interfaces been agreed to between the groups?}**

Recommendations:

- a) MicroBooNE project management should define procedures to formally accept interface agreements between the different working groups before the CD2 review.
- b) The PMT group should follow these new procedures and document their interface agreements before the CD2 review.

Response:

MicroBooNE project management has recently agreed on a procedure for formalizing and documenting interface agreements between different working groups. The PMT group is now in the process of implementing this procedure to document interfaces with all other working groups.

### **Specific Comments and Suggestions**

The committee suggests, if possible, that the PMT group do a long term test of one or two PMTs at cryogenic temperature to assess any degradation as a function of time for the Hamamatsu 5912-02-MOD tubes.

After the CD2 review, a "vertical slice test" of an array of 2-4 PMTs with the full electronics readout chain would be useful for testing the performance and long-term properties of the complete system.

Response:

As mentioned above, both the longevity tests on 1-2 PMTs at cryogenic temperatures as well as a vertical slice test of a complete array of 2-4 PMTs with the full electronics chain will be carried out, as recommended, after the CD2 review.